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22 JAN 1998
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1/77

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in)

1. Your reference

PDG/20388

2. Patent application number *(The Patent Office will fill in this part)*

9801382.4 22 JAN 1998

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

SNELL & WILCOX LIMITED
6 Old Lodge Place
St Margaret's
Twickenham
Middlesex TW1 1RQ

Patents ADP number *(if you know it)*

5579784003

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

VIDEO SIGNAL COMPRESSION

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MATHYS & SQUIRE

100 Gray's Inn Road
London WC1X 8AL
UNITED KINGDOM

Patents ADP number *(if you know it)*

1081001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

Yes

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	6
Claim(s)	2
Abstract	-
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature MATHYS & SQUIRE Date 22 Jan 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

Peter D Garratt - 0171 830 0000

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VIDEO SIGNAL COMPRESSION

The invention relates to video signal compression.

In an important example, the invention concerns the MPEG-2 video signal compression standard, ISO/IEC 13818-2, though it can be applied to any video compression system that is liable to degradation when coding and decoding are cascaded.

There has already been disclosed (WO-A-9535628) the use of a signal which accompanies an MPEG bitstream and which carries information about the bitstream for use in a downstream process, for example, the re-encoding of a decoded MPEG picture. This signal is provided in parallel and is sent along an appropriate side channel to accompany a decompressed signal from a compression decoder to a subsequent encoder.

Where equipment has been specifically designed for use with such a signal, considerable advantage can be gained and many of the problems previously associated with cascaded coding and decoding processes are removed or ameliorated by using in a downstream coding process, key information concerning upstream coding and decoding.

In PCT/GB97/01862, there are disclosed techniques which extend these advantages, in part or in whole, to arrangements which include equipment not specifically designed for use with such a signal. Specifically, these techniques include embedding the information signal in the video signal so that it can pass transparently through a video pathway.

It is an object of this invention to provide improved apparatus and processes which offer benefits not just in a cascaded recoding operation but in a primary coding operation.

Such a primary coding operation will usually be applied to a video signal which has not previously been compressed. The possibility is included, however, of a "primary" coding operation on a video signal which has been compressed but without advantage having been taken of

any of the techniques disclosed in either of the above referenced documents.

Accordingly, the present invention consists, in one aspect in a video signal process comprising the steps of analysing a video sig and taking compression coding decisions; forming a representation of the coding decisions for passage with the video signal along a video pathway and downstream of the video pathway compression encoding the video signal in accordance with said coding decisions.

The coding decisions may include the following information: picture dimensions; frame rate; picture structure (frame-coded or field-coded); picture type (I,P or B); whether macroblocks are intra-coded or use prediction; whether forward, backward or bi-directional prediction is used; motion vectors; transform type; quantizer visibility weighting matrices; quantizer step; bit rate and buffer state of a downstream decoder.

In this description, the term Information Bus is used to represent information relating to a coding operation, which information accompanies a decoded signal, a partially decoded signal or a yet-to-be-coded signal. More detail can be found with reference to WO-A-9535628. The term Information Stream is used here to mean an Information Bus embedded within a video signal for example as disclosed in PCT/GB97/01862.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a compression pre-processor according to this invention; and

Figure 2 is a block diagram illustrating three alternative sever-based processes according to this invention making use of the information provided by the pre-processor of Figure 1.

Figure 1 shows a possible configuration of a compression pre-processor with Information Stream output. An Information Bus generator generates a 'skeleton' Information Bus containing picture, GOP and sequence rate information relating to the input video signal, for example, picture size, aspect ratio, field/frame coding type and picture type. The

motion estimator then generates candidate motion vectors which are placed on the Information Bus. The prediction selector selects between the different candidate motion vectors and selects which prediction mode (field, frame, forward, backward, bidirectional etc.) is to be used for each macroblock. It also performs inter/intra selection and DCT type selection. The Information Bus at the output of the prediction selector contains all the decisions necessary for the creation of an MPEG bitstream apart from those relating to quantization. These are provided by the bit rate controller, which works at a notional bit rate representing the likely future use of the Information Stream. The dumb coder then generates a bitstream at the desired notional bit rate and places the quantizer information on the Information Bus.

So far, what has been described is identical to an MPEG coder based on the Information Bus. In this application, however, the bitstream is not used and only the final Information Bus appears at the output. This Information Bus is then converted into an Information Stream using techniques described in PCT/GB97/01862. The Information Stream forms the output of the pre-processor, alongside a suitably delayed version of the input video signal.

Alternative versions of this pre-processor are:

- two or more dumb coders and associated bit rate controllers could work in parallel, each at a different bit rate covering the range of likely future requirements. The quantizer information generated at each bit rate could be recorded in the Information Stream.

- the bit rate controller could be removed and the dumb coder or coders could work with a fixed quantizer or quantizers. The resulting numbers of bits generated for each macroblock could then be recorded in the output Information Bus

- the pre-processor could consist of a standard MPEG coder followed by an Information Stream generating decoder

Figure 2 shows how the pre-processor might be used in conjunction with a server designed for uncompressed video signals. The pre-processor works as described above to add an Information Stream to a digital video signal. The resulting video + Information Stream signal is written onto a server. We then show three examples of how the signal might be used at some future date to produce bitstreams.

In each example, the signal is read from the server and sent to an Information Stream decoder which passes the resulting video and Information Bus signals to a dumb coder.

In the first example, dumb coder 1 simply slaves to the incoming video and Information Bus signals and produces a bitstream at the bit rate generated by the pre-processor.

In the second example, dumb coder 2 works at a new bit rate. The quantizer information in the Information Stream is ignored and is replaced by quantizer information calculated by the local bit rate controller.

In the third example, (enhanced) dumb coder 3 makes use of both the local bit-rate controller and the quantizer or bit-count information decoded from the Information Stream to improve the performance of the encoder. Effectively, we have the benefit of pre-analysis and a second pass through the bit rate control process. Such two-pass encoding is well known in the art.

Either of the second two configurations could be used as part of a bitstream switch or other bitstream processor in which it is necessary to control the bit rate and the occupancy of the coder buffer.

There are various possibilities for the format of an Information Stream signal, according to its timing relationship with the video signal it accompanies. Examples of possible formats for the Information Stream signal are as follows:

i) A fixed-bit-rate signal but containing a variable number

of bits per picture and transmitted with no regard for synchronisation to the video signal. In practice, the Information Stream could have a variable bit-rate but could be made to occupy a fixed-bit-rate channel by the use of stuffing bits

ii) A fixed or variable-bit-rate signal which is re-ordered (from bitstream order to display order within the GOP structure) and time-shifted so that the Information Stream for each picture is co-timed with the video signal for that picture.

iii) A mixture of the two, in that the Information Stream itself is asynchronous but a small slot is reserved for some picture-locked data; this would carry, for example, duplicates of **time_code** and **picture_type.**

iv) A fixed-bit-rate signal which is re-ordered and time-shifted as described in the second option above, but additionally arranged so that the macro-rate information for each macroblock is co-timed with the video signal corresponding to the macroblock.

A number of ways have been identified in which the Information Stream might be transported along with a digital video signal. Examples are as follows:-

i) In the least significant bit of the colour-difference part of a 10-bit ITU-R Rec. 656 signal, within the active video region only. This provides a raw bit-rate of 10.368 Mbit/s for the Information Stream. Care will be taken to ensure that the presence of the Information Stream does not cause visible impairments to the video signal and that studio equipment quoted as '10 bits' is indeed transparent to all ten bits of the signal when no mixing or other processing is being performed. This option for the transport of the Information Stream is thought to be particularly ingenious. In other implementations, the Information Stream might be transported in the 9th or 8th colour-difference bit, in the 10th, 9th or 8th luminance bit or in any combination of the above. Use of the 8th bit would also be appropriate for systems using earlier versions of the Rec. 656 standard where only 8-bit

representation is available.

ii) An extension of the above approach, in which any part of the digital video signal (not just the least significant bit) is modified by adding Information Stream data in such a way that a downstream MPEG coder would be unaffected.

iii) In the ancillary data channel carried in the blanking periods of the Rec. 656 signal. It would be necessary to ensure that studio equipment passed this information unchanged when no mixing or other processing was being performed.

iv) As an AES/EBU digital audio channel. This would be passed through a spare channel in the audio path of the studio equipment. It would be necessary to ensure that switching of that particular audio channel would be performed along with the video switching, even though the main audio channel(s) might be switched independently of the video.

Whilst the use of an Information Bus which is effectively the MPEG stream minus the DCT coefficients, is extremely convenient, other options exist for representing the coding decisions. A range of formats could be employed and various compression techniques employed. In addition to the coding decisions useful statistical information can also be carried.

Note that the present invention and the Information Stream concept are not confined to MPEG compression. It could be used with any compression technique, or even with a mixture, although in this case the processing of the decoded Information Stream would be significantly more complicated, as it would involve the re-interpretation of coding mode information for a different compression scheme.

It should be understood that this invention has been described by way of examples only and a variety of further modifications are possible without departing from the scope of the invention.

CLAIMS

1. A video signal process comprising the steps of analysing a video signal and taking compression coding decisions; forming a representation of the coding decisions for passage with the video signal along a video pathway and downstream of the video pathway compression encoding the video signal in accordance with said coding decisions.

2. A process according to Claim 1 wherein said representation of the coding decision comprises an information bus in which the coding decisions are represented in the same format as they are represented in the compressed bitstream which is the output of said downstream compression coding operation.

3. A process according to Claim 1 or Claim 2, wherein said analysis generates information relating to picture size and type.

4. A process according to any one of the preceding claims, wherein said analysis comprises the generation of candidate motion vectors.

5. A process according to Claim 4, wherein said analysis comprises the selection for each macroblock of the picture of a motion vector from said candidate motion vectors.

6. A process according to Claim 5, in which said analysis comprises the selection of a macroblock prediction mode.

7. A process according to any one of the preceding claims wherein said analysis includes a bit rate control and the taking of quantizer decisions appropriate to the maintenance of the selected bit rate.

8. A process according to Claim 5 wherein plural bit rates are selected and plural quantizer decisions taken.

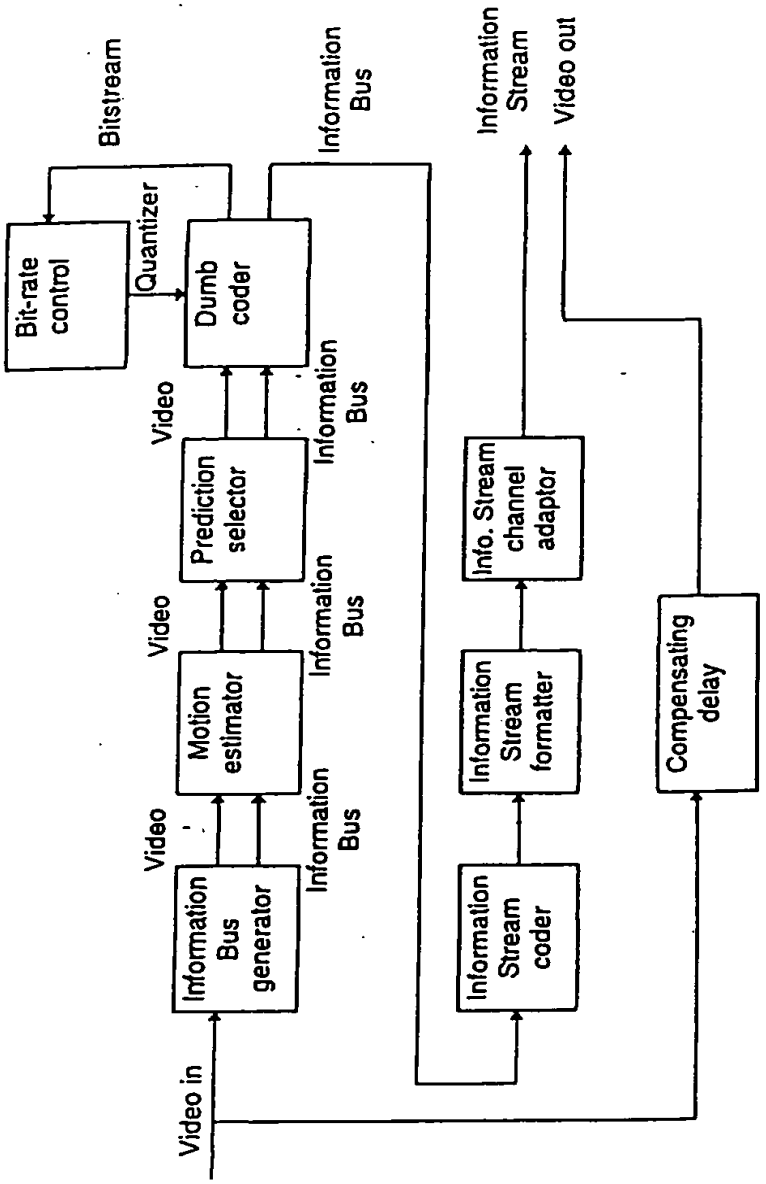
Bitstream
Information Bus
Information Stream
Video out
Bit-rate control
Quantizer
Dumb coder
Video
Information Bus
Prediction selector
Video
Information Bus
Motion estimator
Video
Information Bus
Information Bus generator
Info. Stream channel adaptor
Information Stream formatter
Information Stream coder
Compensating delay
Video in

FIGURE 1

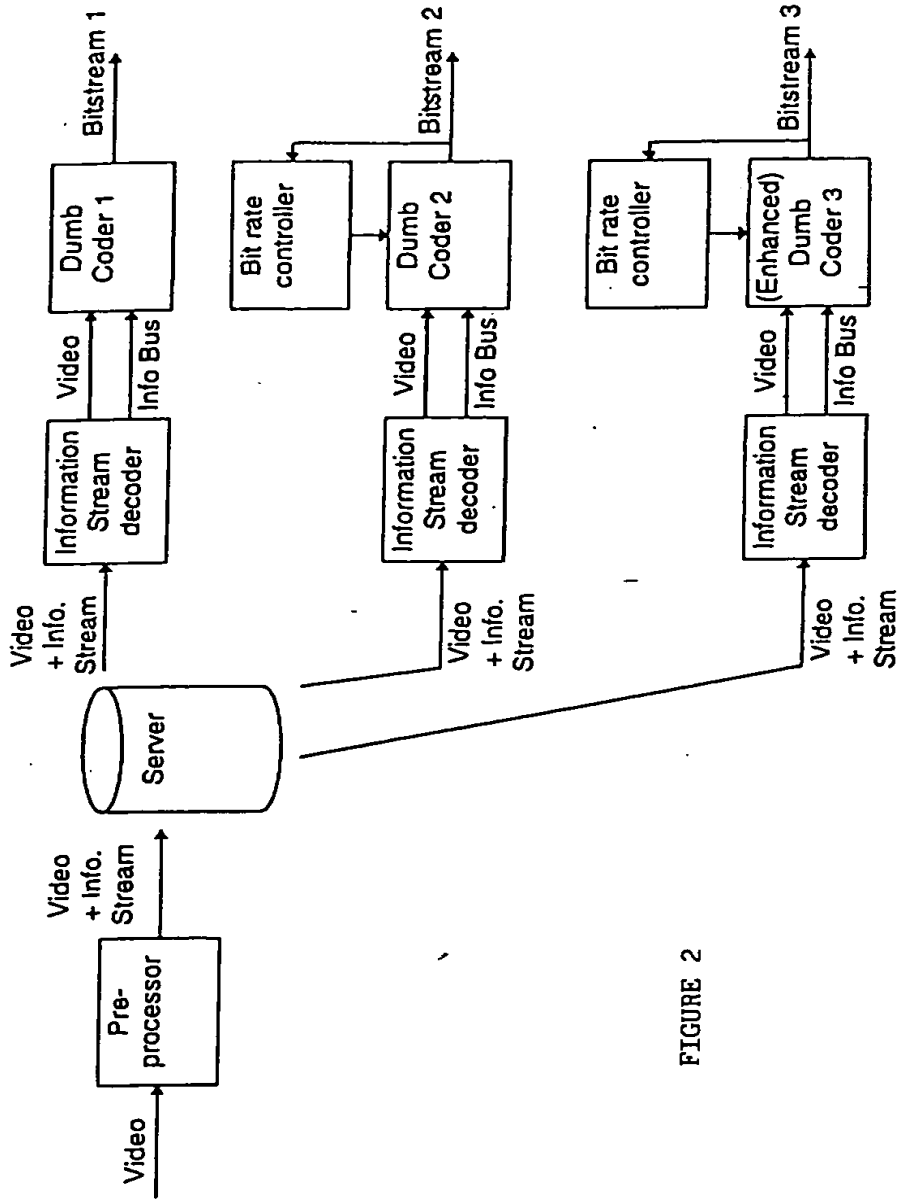
Video
Pre-processor
Video + Info. Stream
Server
Video + Info. Stream
Video + Info. Stream
Video + Info. Stream
Information Stream decoder
Video
Info Bus
Dumb Coder 1
Bitstream 1
Information Stream decoder
Video
Info Bus
Bit rate controller
Dumb Coder 2
Bitstream 2
Information Stream decoder
Video
Info Bus
Bit rate controller
(Enhanced) Dumb Coder 3
Bitstream 3

FIGURE 2

PCT/GB99/00228

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